

# Overcoming Threshold Concepts in Undergraduate Physics

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## Research Goals

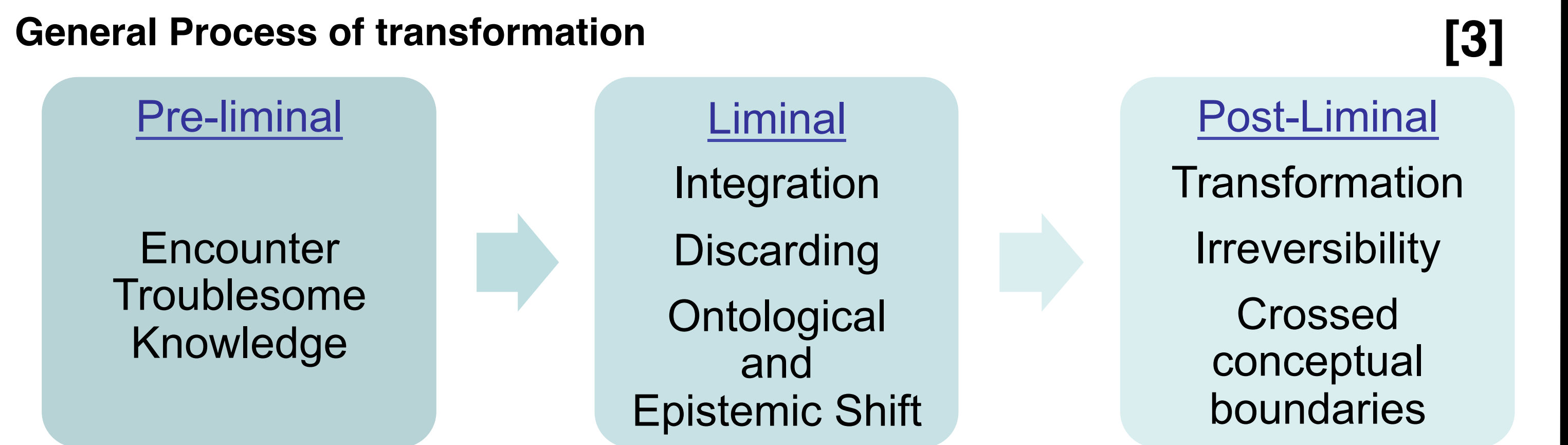
- 1. To characterise and find examples of threshold concepts in undergraduate physics
- 2. To identify, if it exists, a commonality in process of overcoming threshold concepts
- 3. To guide future teaching of threshold concepts

## Motivation

- Overcoming threshold concepts is crucial to mastery of subject [1]
- Identifying threshold concepts to guide teaching has had success in other disciplines (e.g economics) [2]
- This research is motivated by a desire to characterise threshold concepts in physics and to determine how best to overcome them

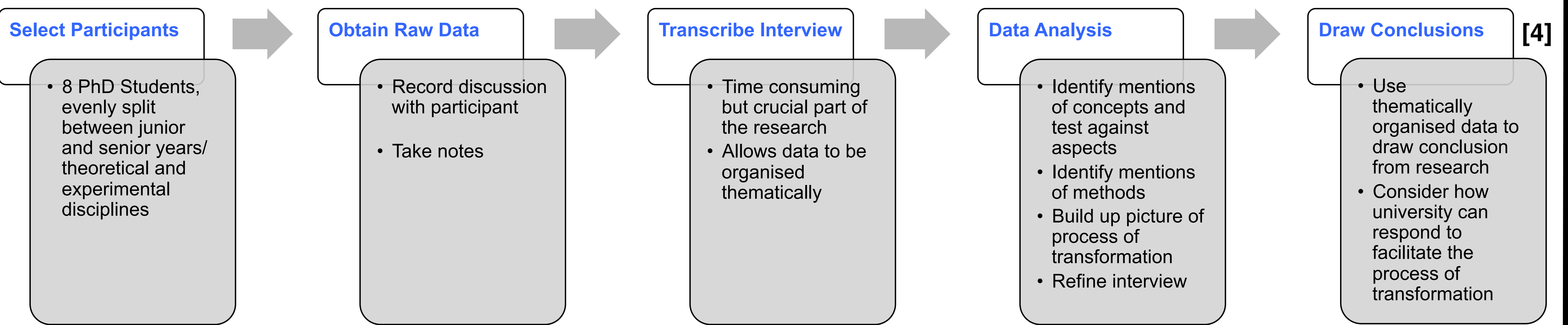
## Background

- Threshold concepts within a discipline are concepts that are required to be understood in order to progress.
- Theory: a way of breaking things down to understand how successful learning occurs
- Overcoming a threshold concept can be seen as a transformation



Key Aspects of Threshold Concepts		
Transformative	Integrative	Challenging
Overcoming a threshold concept changes the way a student thinks	Threshold concepts are likely to exist at the boundaries of sub disciplines. Overcoming them will illuminate connections between areas in physics	Threshold concepts are likely to be complex, alien and/or counter-intuitive

## Method: Qualitative Analysis



## Results: Concepts and Methods

1.

2.

3.

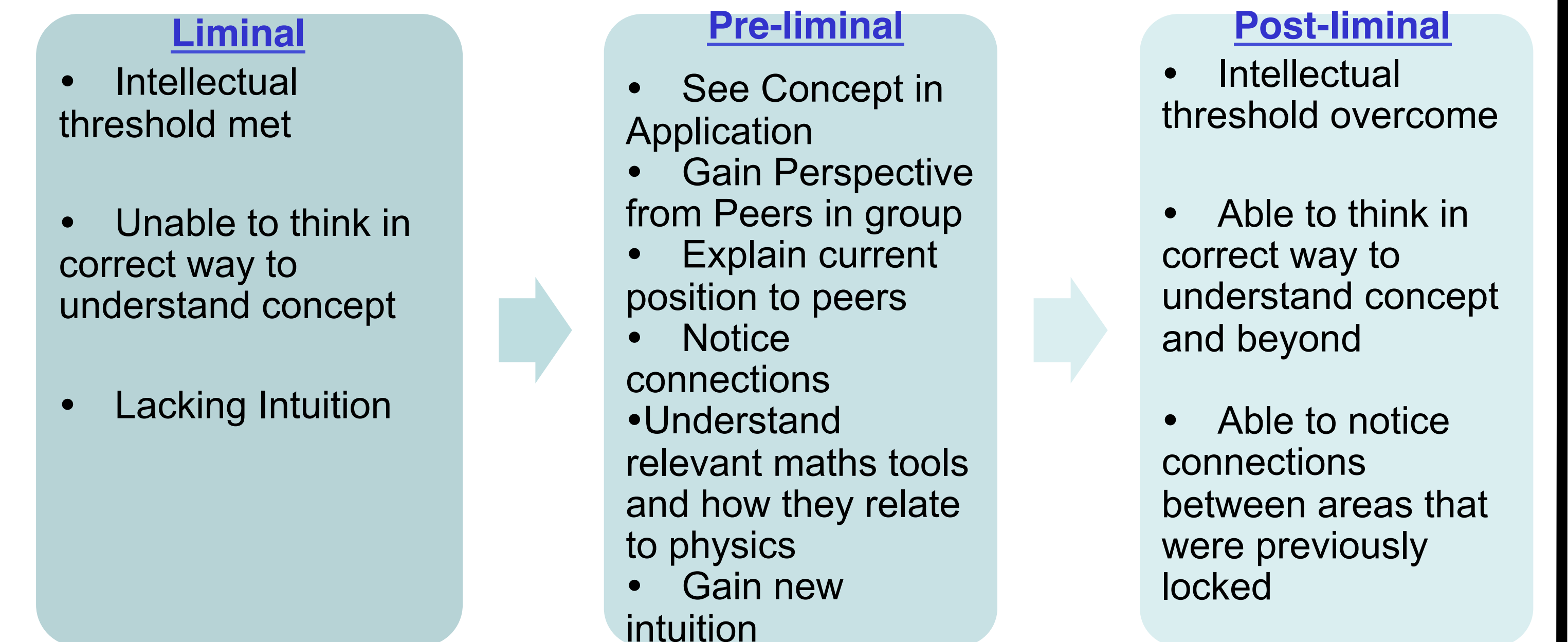
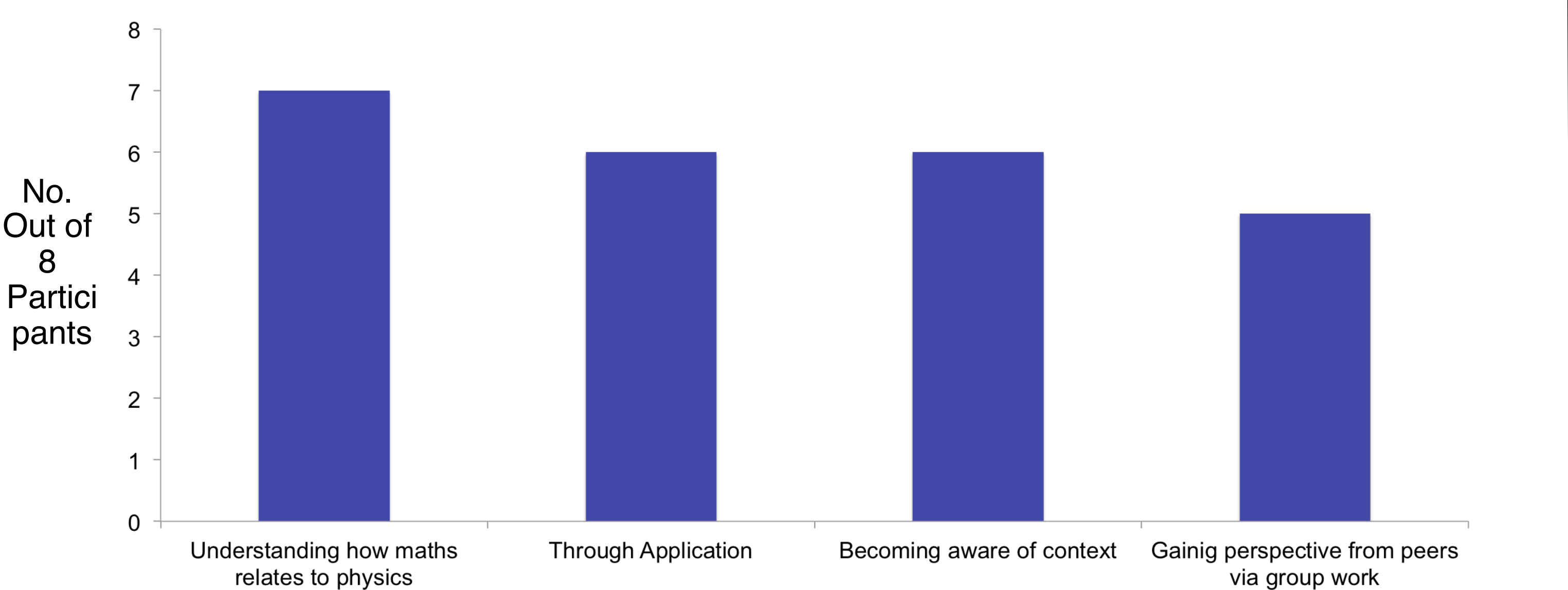
$$\begin{aligned}\nabla \cdot \mathbf{D} &= \rho \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\ \nabla \times \mathbf{H} &= \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}\end{aligned}$$

4.

**Selected Threshold Concepts Mentioned**

- Fourier Analysis
- Lorentz Transformations
- Maxwell's Equations
- Born Rule

- All 8 participants related to the experience of overcoming threshold concepts, however remembering specific concepts was not always possible. The graph characterises the most common methods employed to overcome threshold.



Process of transformation specific to undergraduate physics (from data) i.e a summary of responses organised in terms of stages of transformation according to the literature.

## Conclusions and Outlook

- Threshold Concepts are relevant to undergraduate physics courses
- Threshold concepts in physics can be characterised as transformative, integrative and challenging
- There is commonality in process of transformation
- Universities could better facilitate the process by using teaching time to apply knowledge, facilitating/encouraging more group work and highlighting context of concepts as part of a greater body of knowledge

**References**  
[1] Land et al, 2010, Threshold Concepts and Transformational Learning, Sense, pp. ix-xlii  
[2] Shanahan et al, 2008, Chapter 12 in Threshold Concepts Within the Disciplines, Land et al, 2008, Sense Publishers  
[3] Cousin, G, 2006, An Introduction to Threshold Concepts, Planet No 17, pp. 4  
[4] Pope et al, 2000, Analysing Qualitative Data, In Pope, C, 2000, Qualitative Research In Healthcare, 2nd Edition, BMJ Books